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5G + Smart Mining Application of Zhunneng Group Company Limited in Inner Mongolia

" The Inner Mongolia Autonomous Region is promoting a three-year action plan for the intelligent coal mine development. The Heidaigou and Haerwusu open-pit coal mines of Zhunneng Group are among China's first batch of demonstration coal mines where we fully utilize benefits of 5G, unmanned driving, remote control and other technologies. In this cooperation with China Telecom, the 5G application helps drive the "1217" development planning of Zhunneng Group and supports the building of a safe, efficient, and green smart mine.

Du Shanzhou
Secretary of the Party Committee and Chairman of Zhunneng Group Company Limited under China Energy

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📖 Case Overview

Zhunneng Group under China Energy Investment Corporation in Inner Mongolia is a large-scale comprehensive energy enterprise specialising in coal mining, pithead power generation, and coal circular economy businesses. The Group owns Heidaigou (the largest coal mine in Asia) and Haerwusu open-pit coal mines (the total annual production capacity of them is 69 million tons) as well as supporting coal preparation plants, coal gangue power plants, industrial pilot plants, etc. Responding to the state's call for building intelligent coal mines and the industry trends, Zhunneng Group launched the "5G + Smart Mining Application" project in the middle of 2021.

The project is currently in the implementation and delivery stage. Applications enabling unmanned driving and remote control of more than 200 mining trucks, 40 electric shovels, and 1,000 auxiliary vehicles in Heidaigou and Haerwusu mining sites are developed and then implemented through 103 newly built 5G macrocells. With emerging communications and computing technologies such as 5G, AI, HD video, big data, and cloud computing, Zhunneng Group's coal mines have achieved intelligent cognition, ubiquitous connection, and precise control of production lines. The adoption of these technologies has further developed more 5G + application scenarios such as unmanned driving, remote control, intelligent coal mining, and intelligent inspection, which can help ensure the intrinsic production safety of open-pit mines and improve production and operation efficiency.

Meanwhile, many technical segments with achievements obtained in the 5G network construction and deployment, including the application of 5G communication network in ultra-large open-pit mines, the application of 5G Super Uplink in ultra-large open-pit mines, the application of network operation and maintenance technologies such as periodic migration of 5G base stations and network optimization, and the application of 5G base station + site energy in scenarios without optical cables and power supply, will form a "planning, deployment, maintenance, and optimization" baseline scheme for 5G + construction in open-pit mining scenarios. Such scheme can be replicated and promoted in the 5G + construction in coal mining, cement and other industries, increasing 5G + applications on a broad scale.

"It is a great honour to work with Zhunneng Group to build a 5G network in Asia's largest open-pit mine that meets the needs of unmanned driving and remote control," said Gu Hongxun, Secretary of the Party Committee, and General Manager of China Telecom Inner Mongolia Autonomous Region branch. "China Telecom is committed to fuelling the digital transformation of enterprises in the autonomous region and has launched the Bilin and Ruyi modes in the field of 5G customized network to support smart mining. In the future, we will deepen our cooperation in exploring 5G application in mines, helping Zhunneng realise its strategies soon."

⚠️ Industry Challenges

The harsh and complex production environment of Zhunneng's open-pit coal mines has resulted in a high rate of occupational diseases among workers and a great number of accidents. The backward and rough management methods have also driven the production and operation costs up to a level much higher than that of other major mining countries. To ensure the intrinsic safety of onsite production, improve operation efficiency, and attract young and highly skilled talents, the coal mining industry is in urgent need of intelligent transformation and upgrading with emerging communications and computing technologies.
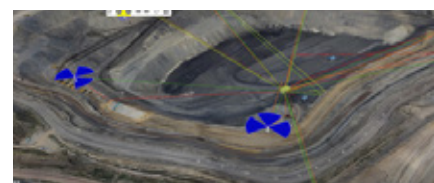
The onsite mining processes of Zhunneng open-pit coal mines include drilling, blasting, stripping, mining, transportation by mining trucks, crushing, and transportation by belt conveyors. These processes require joint operation of core production equipment such as drilling machines, electric shovels, excavators, and mining trucks, and auxiliary production equipment such as loaders, road scrapers, bulldozers, cleaning vehicles, and cranes. Coal mines have complex and diverse geographical environments, require different types and quantity of production facilities in different regional environments, and demand high-availability SLA to support network indicators for business applications. All these result in severer challenges in planning, building, maintaining, and optimizing a 5G network than a traditional wide-area network.

Solutions and Benefits

This 5G + application project is by now the largest one for open-pit mines in China, and even in the world, with innovations in multiple fields including network solutions and service delivery, sharpening its leading edge in the industry.

01 It is the largest project adopting the Ruyi mode of 5G customized network

By deploying a 5G Core network respectively in Zhunneng Group's Heidaigou and Haerwusu coal mines, the project ensured stable, secure, and reliable network signal backhaul of 103 5G macrocells to enable low-latency access to the unmanned driving application platform by more than 200 mining trucks, 40 electric shovels, and 1,000 auxiliary vehicles. The solution can also meet the network capacity demand for intelligent transformation of mining areas in the upcoming five years.

02 It marks the first use of drone-based 3D high-precision electronic mapping as the digital base to serve precise network planning

Real-scene 3D models were built by accurately rendering and reconstructing high-definition images of the mining areas collected by drones. Based on the 3D models, the precise capacity calculations of business applications and the uplink deterministic rate simulation technology were employed to plan the 5G network in the mining areas. This method has addressed the low accuracy of traditional difficult manual surveys.

03 The project is the first in China to use Super Uplink to address demands of unmanned driving, remote control, and other business applications for large uplink bandwidth

China Telecom and Huawei jointly released the Super Uplink technology to meet the large uplink bandwidth demands in toB scenarios. This technology combines 3.5 GHz TDD uplink and 2.1 GHz FDD uplink to enable full-time-slot scheduling of uplink traffic, increasing base stations' near-point rate by 20% to 60% and far-point rate by 2 to 4 times while reducing air interface delay by 30% to better meet the requirements of business applications for network indicators. The combination of this technology and A + P Ultra-Lean Site can increase the antenna height without installing additional poles, so as to improve the coverage by 20%.
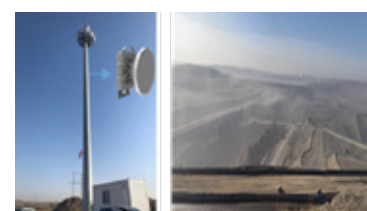
04 The project is the first in China to use a towed intelligent hydraulic platform to address the frequent relocation need of open-pit coal mines' communication base stations

As the production progresses in mining areas, wireless sites need to be relocated frequently. The timeliness and accuracy of site migration are particularly important to eliminate relocation impacts on site operation and plan and optimize the network during the relocation. A towed intelligent hydraulic platform was used for the first time, which is compact-sized and conveniently designed for lifting and towing to meet the quick site migration need in mining operation.

05 Microwave backhaul and oil-electric hybrid solution

This project innovatively introduced the microwave backhaul and oil-electric hybrid solution for scenarios where electric wires and optical cables could not be deployed in the mines. Microwave links replace the original optical cables to send back the BBU-processed information to the bearer network. In addition, microwave frequency signals, like optical cables, can form a loop network. In the cases of a network failure with any route, data can be transmitted via another route to ensure stable transmission. An oil-electricity hybrid solution was adopted in areas where electric wires could not be deployed. The alternated power supply by the oil engine and storage battery ensured power supply in areas without access to the mains supply. This solution is more power-saving and provides a longer service life than the traditional oil engine room.
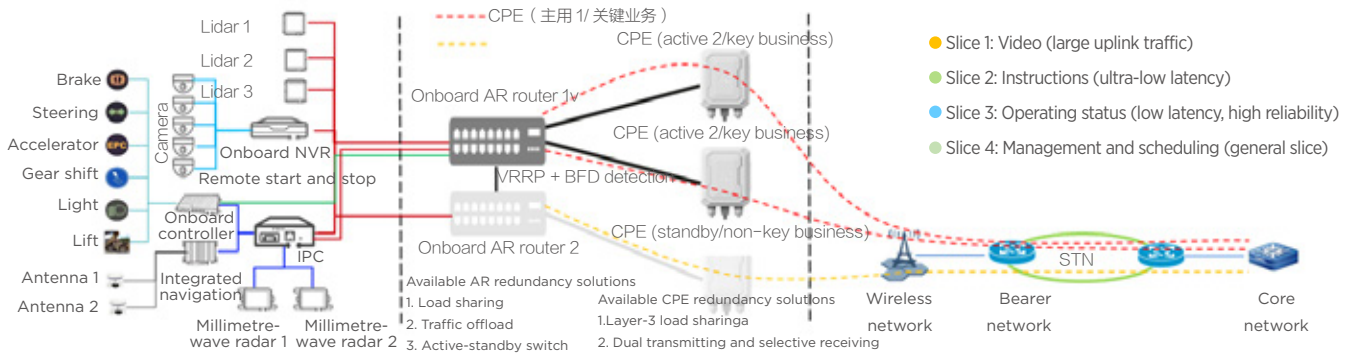
06 The project utilized network slicing to isolate services end-to-end, with the user experience guaranteed.

Different service flows have different network indicator requirements. For example, video service flows have higher requirements on uplink bandwidth stability, and instruction service flows are more sensitive to latency. Different types of data flows can be divided into different network slices to ensure safe and stable transmission of service flows.

07 The dual management platforms ensured efficient operation and maintenance of terminals and networks at the mine sites

The mining truck management platform actively perceives malfunctions and safety accidents to ensure safety, stability, and reliability of vehicles and unmanned driving system. The 5G network self-management platform can quickly identify network issues to shorten production interruption time caused by network failures and support customized application development and efficient network operation and maintenance.

Industry Challenges

Lessons learned

1 Accurate business profiling of terminal-side applications is a key input to support precise planning of 5G networks.

2 Feasibility should be considered during network planning and design, and toB network planning requires customized network schemes for specific industries and scenarios.

3 Risks should be identified in time during the delivery stage, with a risk response plan formulated by stakeholders to ensure delivery quality.

Next steps

1 3D indoor modelling: The project plans to build 3D real-scene models for Zhunneng Group's office buildings and gangue power plants among other indoor spaces utilizing the data matching technology of multi-view point clouds. The 3D indoor models and 3D outdoor models jointly constitute a high-precision mapping digital base for Zhunneng Group's mine sites. The digital base can serve as a foundation for precise planning and optimization of 5G networks. Meanwhile, the SDK plug-ins provided by the digital base can be connected to different subsystems of the mine, such as personnel and vehicle positioning subsystem and geological survey software to demonstrate the subsystems.

2 Video positioning: The project plans to enable decimetre-level positioning based on the visual positioning technology to implement electronic fence monitoring over blasting areas, conveyor belts, and other dangerous operating areas.

3 Intelligent management platform: The project plans to standardise the data formats of different production subsystems in the mining areas by establishing an Industrial Internet platform to break production data silos, better tapping into the value of different production data to improve management and operation efficiency.

4 Edge cloud: The project plans to implement edge clouds in the mining data centres to save investment in hardware equipment, facilitate local operation and maintenance, and ensure rapid deployment and release of new services and new applications.